Part C—Organophosphate (OP) Pesticides

Introduction

This technical support document (TSD) provides additional information relevant to the development of the chlorpyrifos and diazinon TMDLs described in the TMDL summary document. In this TSD, Section I describes physical and chemical properties as well as the environmental fate of chlorpyrifos and diazinon. Section II follows with a usage analysis. Section III gives a summary of the monitoring data collected to date and an analysis of the major sources of chlorpyrifos and diazinon to San Diego Creek and Upper Newport Bay. Section IV presents calculations of current load estimates.

The source analysis focuses on water column concentrations, as these were associated with aquatic life toxicity and impairment of beneficial uses in San Diego Creek and Upper Newport Bay. Several investigations have been conducted in the watershed to characterize aquatic life toxicity associated with pesticides. These studies were not detailed enough to identify discrete sources; however, it is clear that diazinon and chlorpyrifos discharges are associated with nonpoint source runoff from areas where these pesticides are applied.

A large portion of information presented in this Technical Support Document was extracted from the OP Pesticide DRAFT TMDL written by Regional Board staff (2001a).

I. Physicochemical properties and environmental fate

The environmental fate of chlorpyrifos and diazinon can be inferred from their physical properties. Table C-1 presents properties for diazinon and chlorpyrifos along with several other pesticides that occasionally contribute to the aquatic life toxicity in San Diego Creek. In general, diazinon and chlorpyrifos are a more significant water quality threat because of the combined properties of higher toxicity, mobility, and persistence. Carbaryl for example, is mobile but less toxic and less persistent than diazinon and chlorpyrifos.

Table C-1. Pesticide properties

Pesticide	Ceriodaphnia LC 50 (ng/L)	Solubility (mg/L)	Adsorption coefficient	Soil half-life	Water half-life
Bifenthrin	78	0.1	1,000,000	7 days to 8 mos.	n/a
Carbaryl	3,380	40	300	7-28 days	10 days
Chlorpyrifos	60	2	6070	2-4 months	1-2.5 months
Diazinon	440	40	1000	2-4 weeks	6 months
DDT	4,700	<1	100,000	2-15 years	1-2 months
Malathion	1,140	130	2.75	1-25 days	< 1 week

Source: EXTOXNET Pesticide Information Profiles; CDFG (2000)
n/a=not available

Relative to most pesticides, diazinon is fairly soluble and mobile in aquatic systems. It is only weakly bound by sediment. In contrast, chlorpyrifos is much less soluble and has a much higher potential to adsorb to soil and sediment.

Diazinon

In general, diazinon is relatively persistent in aquatic environments with a half-life of about six-months under neutral pH conditions. The pH of the channel network in the Newport Bay watershed is generally between 7.5 and 8, a range that would maintain the stability of diazinon. In soil, the diazinon half life is shorter owing to greater microbial degradation.

For diazinon, the major routes for dissipation appear to be biodegradation , volatilization, and photolysis (USEPA 1999a). Degradation is fastest from bare soil, followed by vegetation, and aquatic environments. Biodegradation from impervious urban areas (walkways, pavement) would be slowest due to the relative absence of microbes. This indicates that diazinon may accumulate in residential areas until rainfall runoff carries it into the drainage channel network. In a residential runoff survey conducted in the Castro Valley Creek watershed, diazinon was found in all samples as long as seven weeks after application.

Diazinon dissipation half-lives did not appear to be correlated with formulation type (granular, wettable powder, or emulsifiable concentrate). The reported diazinon formulations in Orange County for 1999 are listed in Table C-2. The liquid formulations are likely to be the most mobile as they are already in soluble form. The granules would likely remain available until a storm event washed the remaining active ingredient into the storm drains.

Table C-2. Diazinon Formulations for Reported Uses in Orange County, 1999

Formulation	Use (lbs. ai)	Percent
Emulsifiable concentrate	14,776	60.4%
Granular/Flake	4675	19.1
Wettable Powder	2720	11.1
Flowable Concentration	1969	8.1
Liquid Concentration	275	1.1
Dust/Powder	36.8	0.2
Pressurized Liquid/Sprays/Foggers	0.465	0
Solution/Liquid (Ready to use)	0.184	0
Total	24,452	100%

ai =active ingredient

Regardless of the formulation used, runoff is likely to occur only after significant rainfall or irrigation. Aside from runoff, a potentially significant discharge could occur through improper disposal of old or leftover material. The degree of knowledge concerning proper disposal varies considerably and it is unlikely that homeowners apply the exact amount needed in a manner that does not cause runoff.

Large-scale aerial spray applications may drift and result in significant offsite migration. These are generally applied to orchard crops in the Central Valley and, as Table C-2 shows, they are not a significant application in Orange County.

There is evidence that the amount of diazinon in a watershed that reaches a receiving waterbody is generally less than one percent of that applied (Scanlin and Feng 1997). Thus, relatively limited instances of improper use (e.g. inappropriate disposal, excess outdoor application) could account for a large portion of the observed concentrations in the drainage channels.

Chlorpyrifos

Compared to diazinon, chlorpyrifos has a shorter half-life in water, but a longer half-life in soil. This is due in part to its higher adsorption coefficient, which results in chlorpyrifos partitioning out of the aquatic phase as it is bound by sediment and soil.

Table C-3 shows the chlorpyrifos formulations used in Orange County in 1999. As with diazinon, concentrates, powders, and granular/flake formulations account for over 99% of the uses. These formulations require mixing/preparation prior to use.

Table C-3. Chlorpyrifos Formulations used in Orange County, 1999

Formulation	Use (lbs. ai)	Percent
Emulsifiable concentrate	70,067	87.6%
Granular/Flake	6571	8.2
Wettable Powder	2281	2.9
Flowable Concentration	996	1.2
Liquid Concentration	38.1	0
Dust/Powder	35.1	0
Pressurized Liquid/Sprays/Foggers	1.58	0
Solution/Liquid (Ready to use)	0.103	0
Total	79,990	100%

ai = active ingredient

Of the top four formulations used in Orange County, only the granular/flake formulation would act to slowly release the active ingredient into the water, while the other formulations would enhance mobility. The lower release rate would result in lower concentrations over time.

Dissipation of chlorpyrifos from water takes place through sorption, volatilization, and photolysis. Chemical breakdown (hydrolysis) rates increase with increasing temperature and pH. Adsorbed chlorpyrifos is subject to degradation by UV light, chemical hydrolysis, and biodegradation.

II. Pesticide Usage

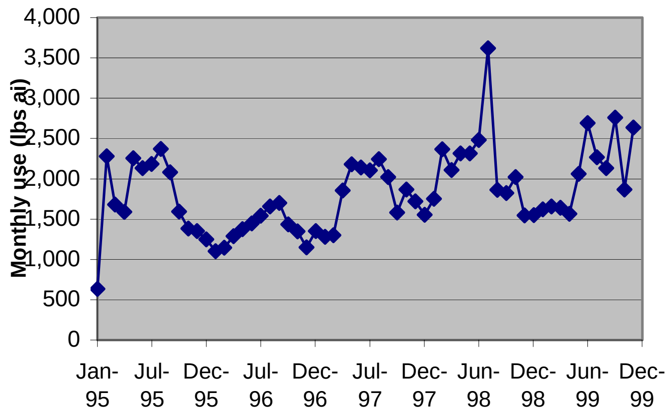
The CDPR requires records of all pesticide applications except for residential use by homeowners. These records are compiled and reported on a county-by-county basis. The Newport Bay watershed occupies 20% of Orange County, and it is assumed here that 20% of the pesticide use reported for Orange County occurred within the Newport Bay watershed.

Diazinon

As shown in Figure C-1, reported diazinon use in Orange County has remained fairly steady over the past five years. Seasonally correlated increases in diazinon use are apparent in the summer months in response to increased pest activity.

As noted above, residential use by homeowners is not reported in the CDPR database. Information on national pesticide usage by homeowners is available from the USEPA Pesticide Industry Sales and Usage Market Estimates report. On a national basis, 75% of the diazinon used in the US each year is for non-agricultural purposes, with 39% used by homeowners outdoors and 3% used by homeowners indoors (USEPA 1999b). Total homeowner use is therefore about 42% on a national basis.

Figure C-1: Reported Diazinon Use
Orange County: 1995-1999



In Orange County, the total agricultural use is likely less than the national average due to urbanization of the watershed. Thus homeowner uses probably account for more than the 42% reported nationally. A more specific estimate of the unreported homeowner use can be obtained by assuming the national ratio of homeowner use to total non-agricultural use (42/75, or 56%) is applicable to Orange County. Since data on the total non-agricultural diazinon use in Orange County is reported to the CDPR on a yearly basis, the national ratio can be used to estimate the unreported homeowner use in Orange County. Estimating the unreported homeowner use at 56% of total non-agricultural use results in a figure of 29,119 lbs. active ingredient (ai) for 1999. This would amount to 54% of total use (including agricultural use) in Orange County; somewhat higher than the national figure of 42% reported by USEPA.

Tables C-4 and C-5 present the reported and estimated unreported diazinon use in Orange County. For 1999, the total diazinon use in the Newport Bay watershed would be one-fifth of the Orange County total, or approximately 10,714 lbs. ai, while the estimated residential use would be about 5,824 lbs. ai.

Table C-5 indicates that urban uses accounted for over 97% of diazinon use, while agricultural uses (including nurseries) accounted for the remainder. Data from the Sales and Use Survey in the Newport Bay watershed (Wilen 2001) indicate that unreported residential diazinon use in 2000 was about 7,864 lbs. ai; about 32% larger than the estimate of 5,919 lbs. presented above using separate national data. This would suggest that total urban uses account for more than the 97% indicated in Table C-5.

Table C-4: Reported and Estimated Diazinon Use
Orange County: 1995-1999 (lbs. ai)

Use	1995	1996	1997	1998	1999
Structural	17,463	14,046	18,892	23,076	22,085
Nursery	1,037	839	803	1,212	1,144
Agriculture	2,004	746	1,363	865	429
Landscape	1,030	762	595	612	789
Other non-residential	9.8	46.2	1.6	1.7	5.3
Reported subtotal	21,543	16,439	21,655	25,766	24,452
Estimated Unreported Residential Use	23,548	18,905	24,804	30,150	29,119
Total	45,092	35,344	46,458	55,915	53,571

ai = active ingredient

Tables C-4 and C-5 show a decline in agriculture use from 1995 to 1999, both in absolute and percentage terms. The land use data also show a similar pattern, and the decline in agricultural diazinon usage may be a reflection of the continuing conversion of agricultural land to urban uses in Orange County and the Newport Bay watershed.

Table C-5: Reported and Estimated Diazinon Use
Orange County: 1995-1999 (percent)

Use	1995	1996	1997	1998	1999
Structural	38.7%	39.7%	40.7%	41.3%	41.2%
Nursery	2.3%	2.4%	1.7%	2.2%	2.1%
Agriculture	4.4%	2.1%	2.9%	1.5%	0.8%
Landscape	2.3%	2.2%	1.3%	1.1%	1.5%
Other non-residential	0.0%	0.1%	0.0%	0.0%	0.0%
Estimated Residential	52%	53%	53%	54%	54%
Total	100%	100%	100%	100%	100%

USEPA Phaseout of Certain Diazinon Uses

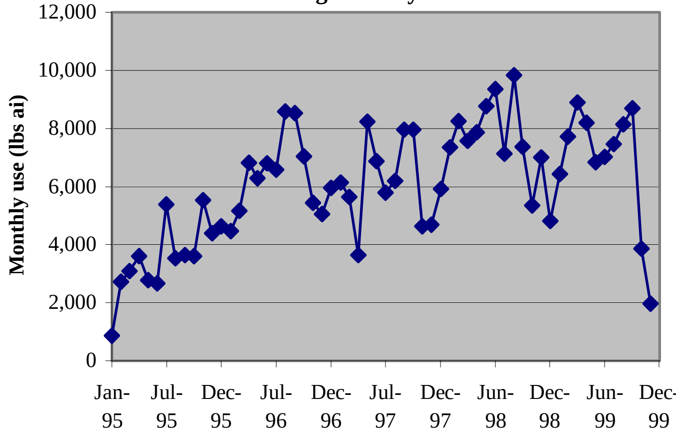
In January 2001, USEPA released a revised risk assessment and an agreement with registrants to phase out most diazinon uses (USEPA 2001b). Under the agreement, all indoor uses will be terminated, and all outdoor non-agricultural uses will be phased out over the next few years. Indoor uses will be banned after December 31, 2002. The EPA expects that these actions will end about 75% of the current use of diazinon. In addition, on a national basis, about one-third of the agricultural crop uses will be removed. For the San Diego Creek / Newport Bay watershed, the percentage reduction in agricultural usage will be higher (ca. 55%) due to the particular crops that are grown in the watershed.

The usage data in Table C-5 show that non-agricultural and non-nursery uses account for over 90% of the diazinon use in Orange County. It is thus likely that the EPA agreement will result in the cessation of most diazinon use in the Newport Bay watershed soon after the outdoor non-agricultural use registration expires on December 31, 2004.

Chlorpyrifos

Figure C-2 shows the reported chlorpyrifos use in Orange County from 1995 to 1999. As with diazinon, higher use tends to occur in the dry season, and is likely correlated with increased pest activity during warmer weather. An increasing trend from 1995 to 1998 is apparent followed by a sharp drop in 1999. This drop may be due to the agreement between EPA and the manufacturers to begin phasing out certain uses of chlorpyrifos (see below).

Fig C-2: Reported Chlorpyrifos Use Orange County: 1995-1999



Tables C-6 and C-7 show the reported and estimated unreported chlorpyrifos use in Orange County. While overall chlorpyrifos use declined in 1999, nursery use increased by 300 percent. The significant increase in chlorpyrifos use by nurseries is likely due to the requirements imposed by the CDFA under the RIFA program. Runoff of the solution from the treatment area is not permitted (CDFA 1999).

Table C-6: Reported and Estimated Chlorpyrifos Use Orange County: 1995-1999 (lbs. ai)

Use	1995	1996	1997	1998	1999
Structural	38,263	72,174	69,865	88,985	74,904
Nursery	652	772	971	994	2,913
Agriculture	1,414	952	1,450	645	1,132
Landscape	1,446	1,230	1,374	1,082	1,005
Other non-residential	7	268.5	1.6	1.6	35.3
Reported subtotal	41,782	75,396	73,662	91,707	79,990
Estimated Residential	21,663	40,185	38,859	49,128	41,424
Total	63,445	115,580	112,520	140,835	121,414

ai = active ingredient

Unreported (residential) chlorpyrifos use can be estimated by determining the national ratio of unreported home use to licensed (non-agricultural) use as reported in the USEPA Market Estimates Report (USEPA 1999b). Nationally, in 1995/96, the residential use was estimated at 2-4 million lbs. ai, while the licensed (non-agricultural) use was estimated at 4-7 million lbs. ai. Using the midpoints of these ranges, the ratio of residential use to licensed non-agricultural use is 0.545 on a national basis. Applying this ratio to the licensed non-agricultural use in Orange County reported to the CDPR for 1999 (75,944 lbs. ai) yields an estimate of 41,424 lbs. ai unreported residential use (Table C-6). This indicates that the unreported residential use was roughly 34% of the total use in 1999 (Table C-7). Total chlorpyrifos use in the Newport Bay watershed for 1999 would be approximately 24,300 lbs. ai (one-fifth of the Orange County total).

Data from the Sales and Use Survey (Wilen 2001) indicates that retail sales of chlorpyrifos in the Newport Bay watershed may have declined to as little as 546 lbs. ai on an annual basis in 2000. This compares to the estimated residential use of 8,285 lbs. ai (one-fifth of the Orange County total) presented in Table C-6 for 1999. The decline in chlorpyrifos use appears to be a continuation of the trend shown in Figure C-2 toward the end of 1999, and is likely related to the re-registration agreement for chlorpyrifos (see below).

Table C-7: Reported and Estimated Chlorpyrifos Use
Orange County: 1995-1999 (percent)

Use	1995	1996	1997	1998	1999
Structural	59.2%	61.9%	61.3%	62.7%	60.6%
Nursery	1.0%	0.7%	0.9%	0.7%	2.4%
Agriculture	2.2%	0.8%	1.3%	0.5%	0.9%
Landscape	2.2%	1.1%	1.2%	0.8%	0.8%
Other non-residential	0.0%	0.2%	0.0%	0.0%	0.0%
Reported subtotal	66%	65%	65%	65%	66%
Estimated Unreported Residential Use	34%	35%	35%	35%	34%
Total	100%	100%	100%	100%	100%

An analysis of chlorpyrifos sales data provided by Dow AgroSciences indicates that treatment for wood protection accounts for 70% of urban use (Giesy et al. 1998). Typical applications involve subsurface injection of chlorpyrifos at relatively high concentrations. Another 14% of urban use was categorized as home use (indoor pests, pet collars, lawns and gardens, building foundations, and other structural applications), while non-residential turf applications accounted for 7% of urban use.

USEPA Phaseout of Certain Chlorpyrifos Uses

In June 2000, the EPA published its revised risk assessment and agreement with registrants for chlorpyrifos (USEPA 2000b). The agreement imposes new restrictions on chlorpyrifos use in agriculture, cancels or phases out nearly all indoor and outdoor residential uses, and also cancels non-residential uses where children may be exposed. Application rates for non-residential areas where children will not be exposed (golf courses, road medians, industrial plant sites) will be reduced. Public health use for fire ant eradication and mosquito control will be restricted to professionals. Non-structural wood treatments will continue at current rates. Since the EPA estimates that about 50% of the chlorpyrifos use (both licensed and unreported) takes place at residential sites, the agreement is likely to result in at least a 50% decrease in chlorpyrifos use.

In Orange County, residential use (reported and unreported) likely accounts for over 90% of total chlorpyrifos use (most of the reported use is for structural protection applied in and around homes). Thus, it appears that over 90% of the current chlorpyrifos use in the Newport Bay watershed will be eliminated by the EPA agreement. Retail sales are scheduled to stop by December 31, 2001, and structural uses will be phased out by December 31, 2005.

As noted above, the CDPR data, and the Sales and Use Survey data (Wilen 2001) indicate that chlorpyrifos use has been declining sharply within the last two years. This is likely due to the warning from EPA that retailers should not purchase stock unless they were able to sell it by December 31, 2001. A survey conducted in northern California in late 2000 noted, “Chlorpyrifos products have become increasingly difficult to find” (TDC Environmental 2001). It should be noted that the available water-quality data for the Newport Bay watershed, is largely from 1996-2000, and not directly correlated to the latest usage data from 2000-2001.

III. Source Analysis

This section presents an analysis of the sources of diazinon and chlorpyrifos in the Newport Bay Watershed. Each chemical summary includes monitoring data and a discussion of diazinon and chlorpyrifos sources categorized by land use. Point sources and non-point sources are also discussed in a separate section.

Diazinon Data Summary

Table C-8 summarizes the results of diazinon sampling in the Newport Bay watershed. The sampling programs are described in Section 2. The table shows the high diazinon detection frequency, particularly during stormflow. The observed diazinon concentrations are similar to those observed in urban watersheds elsewhere in California. The mean values for both baseflow and stormflow exceeded the chonic numeric target, while 86% of the diazinon concentrations observed in the watershed drainage channels exceeded the acute numeric target.

Table C-8. Summary of Diazinon Sampling Results

Source	Count	# of Detects	Det. Freq.	Min.	Max.	Mean	Median
Water Samples (ng/L)							
Drainage Channels (All Flows)	198	185	93%	<40	10,000	471	220
Baseflow	104	93	89%	<40	10,000	473	160
Stormflow	94	92	98%	<50	7990	451	357
Upper Newport Bay	26	26	100%	197	720	386	357
Rainfall	1	1	--	--	13	--	--
Sediment Samples (ug/kg)							
Drainage Channels	98	2	2%	<10	49	--	--
Newport Bay	64	2	3%	<0.4	60	--	--

Freshwater Numeric Targets: acute = 80 ng/L; chronic = 50 ng/L (CDFG 2000a)

For comparison, the median diazinon concentration in the Santa Ana River downstream of Prado dam was 100 ng/L (USGS 2000), and the detection frequency was 99% (72 of 73 samples). The USGS also reported stormflow concentrations as significantly elevated relative to baseflow concentrations.

The low detection frequency for the sediment samples is in accordance with the moderately low diazinon adsorption coefficient, and its relatively high solubility. All the sediment detections were reported from samples collected in 1994, and diazinon has not been detected in subsequent semi-annual sediment sampling.

Table C-9 presents the data summarized by waterbody group. Highest concentrations occur in the upstream tributary channels to San Diego Creek. The maximum concentrations collected in 1998 from Hines Channel (which drains to Peters Canyon Channel) were three baseflow samples with concentration ranging from 2,500 to 10,000 ng/L. The maximum concentration of six baseflow samples collected in Hines channel during 2000, was 323 ng/L, indicating either a decrease in usage or more effective runoff control.

Table C-9: Diazinon Results by Waterbody Group

Waterbody	Count	Results (ng/L)				Exceedances	
		Min	Max	Mean	Median	Above acute	Above chronic
Tributaries to SDC Reach 2	24	40	7,990	817	256	96%	92%
Tributaries to SDC Reach 1	21	49	628	226	134	86%	67%
Tributaries to P CC	41	40	10,000	791	271	83%	78%
Peters Canyon Channel	15	170	820	390	367	100%	100%
SDC Reach 1	59	50	960	301	215	95%	92%
Tributaries to UNB	35	40	2,250	357	202	94%	91%

SDC=San Diego Creek; PCC=Peters Canyon Channel; UNB=Upper Newport Bay
Freshwater Numeric Targets: acute = 80 ng/L; chronic = 50 ng/L

The similarity in median concentrations indicates that there are no clearly dominant areas of the watershed with regard to diazinon loading to San Diego Creek and Upper Newport Bay. Concentrations in Peters Canyon Channel are somewhat elevated relative to the other segments of the drainage network. This was also a conclusion of the 319h study (Lee and Taylor 2001a)

San Diego Creek Reach 2: There were no sampling stations within Reach 2 of San Diego Creek. However, 24 samples were collected from tributary channels (Bee Canyon and Marshburn Slough). These samples were collected several miles upstream of where these channels join San Diego Creek and were mainly targeted at monitoring nursery discharges. The median concentration for these samples was 256 ng/L, with maximum concentrations of 7,990 ng/L during stormflow and 2,320 ng/L during baseflow. Over 90% of the observed concentrations exceeded the acute and chronic numeric targets.

San Diego Creek Reach 1: The main tributary to San Diego Creek Reach 1, (aside from Reach 2), is Peters Canyon Channel. Median diazinon concentrations in Peters Canyon Channel (367 ng/L) were higher than in San Diego Creek (208 ng/L). The median concentration for other tributaries to San Diego Creek was 143 ng/L. All 15 samples collected within Peters Canyon Channel exceeded both the acute and chronic numeric targets, while in the tributaries to Peters Canyon Channel, the percentages exceeding the acute and chronic numeric targets were lower, 78% and 83% respectively. Over 90% of the observed concentrations within Reach 1 exceeded the acute and chronic numeric targets.

Upper Newport Bay: The median concentration for drainage channels discharging directly to Upper Newport Bay (East Costa Mesa, Westcliff Park, Santa Ana Delhi) was 202 ng/L. The CDFG has not recommended criteria for diazinon in saltwater, however, the LC-50 for the commonly used test species (*Mysidopsis bahia*) is 4,200 ng/L, and the observed diazinon concentrations were all below this level, with a maximum of 720 ng/L. The USEPA (2000a) has published draft recommended acute and chronic criteria for diazinon in saltwater (820 ng/L and 400 ng/L respectively). The maximum and average results from Upper Newport Bay were below the respective draft USEPA saltwater CMC and CCC.

Diazinon Sources Categorized by Land Use

Tables C-10a and C-10b present the diazinon results by sampling location along with the land use pattern in the monitored sub-watershed. The locations in Table C-10a are sorted according to median stormwater runoff concentration, while in Table C-10b, they are sorted according to median baseflow concentration. Several of the locations were sampled for only baseflow or only stormflow conditions.

Table C-10a: Land Use and Diazinon Stormflow Concentrations
Newport Bay Watershed: 1996-2000

Station	Land Use	Count	Stormflow Results (ng/L)			
			Min	Max	Avg.	Median
Westcliff Park	residential	7	174	1,079	692	678
Drain at Bee Canyon and Portola Pkwy.	nursery	7	126	7,990	1,625	599
Central Irvine Channel – Monroe	ag (nursery)-residential	2	90	810	545	545
Peters Canyon Channel – Walnut	mixed	1	520	520	520	520
East Costa Mesa Channel – Highland Dr.	residential	2	370	560	465	465
Bonita Creek at San Diego Creek	residential	7	69	628	424	456
San Diego Creek - Campus Dr.	mixed	25	96	960	445	375
El Modena-Irvine Channel upstream of Peters Canyon Channel	residential	1	330	330	330	330
Hines Channel - Irvine Blvd.	nursery	9	199	810	455	324
Peters Canyon Channel – Barranca	mixed	10	202	426	321	309
San Diego Creek – Harvard Av.	mixed	2	200	280	240	240
Santa Ana Delhi Channel – Mesa Dr.	residential-urban	10	64	375	171	174
Marshburn Slough – Irvine Blvd.	Nursery	7	96	291	168	136
Sand Canyon Ave - NE corner Irvine Blvd.	agricultural	2	70	110	90	90
San Joaquin Creek - Univ Dr.	agricultural-open	2	<50	<50	<50	<50

At virtually all the locations, the median stormflow concentration is significantly higher than the median baseflow concentration. Since stormwater runoff constitutes about 80% of the volume of water discharged to Newport Bay on an annual basis, this would indicate that the overwhelming majority of the pesticide load would derive from stormflow rather than baseflow. The average concentration is actually higher for baseflow, but this is biased by a few very high detections from 1998 near nurseries. These results have not been observed in later sampling and the nurseries have subsequently instituted measures targeted at reducing pesticide runoff.

Although the sampling network is not detailed enough to identify individual sources (aside from nurseries), two conclusions are apparent:

(1) Stormflow concentrations are virtually always higher than baseflow concentrations. This is particularly the case in the non-agricultural areas.
(2) Residential areas tend to yield the highest stormwater runoff concentrations while the nursery areas tend to yield the higher baseflow concentrations.

Studies reported in the literature indicate that residential hotspots (individual homes) can account for most of the diazinon runoff from a neighborhood. Samples collected from the near vicinity of these residential hotspots (prior to dilution in the storm drain), showed concentrations above 10,000 ng/L (Scanlin and Feng 1997). Such detailed sampling and analysis for pesticides has not been completed in residential areas of the Newport Bay watershed. The residential run-off reduction study is currently in progress but results were not available for these TMDLs.

Table C-10b: Land Use and Diazinon Baseflow Concentrations
Newport Bay Watershed: 1996-2000

Station	Land Use	Count	Baseflow Results (ng/L)			
			Min	Max	Avg.	Median
Hines Channel - Irvine Blvd.	Nursery	10	47	10,000	2,129	862
Drain at Bee Canyon and Portola Pkwy.	Nursery	7	93	2,320	977	637
Central Irvine Channel – Bryan St	agricultural-residential	5	117	1,940	722	570
Peters Canyon Channel – Barranca	Mixed	4	170	820	533	570
Central Irvine Channel – Monroe	ag (nursery)-residential	2	90	840	465	465
San Diego Creek - Coronado St.	Mixed	2	94	365	230	230
Westcliff Park	Residential	9	<40	2,250	432	215
East Costa Mesa Channel – Highland Dr.	Residential	1	210	210	210	210
El Modena-Irvine Channel upstream of PCC	Residential	1	180	180	180	180
San Diego Creek - Campus Dr.	Mixed	28	<50	570	200	160
Santa Ana Delhi Channel - Mesa Dr.	Residential-urban	6	<50	340	149	125
Bonita Creek at San Diego Creek	Residential	12	49	332	139	114
El Modena	Nursery	3	<40	310	146	87
San Diego Creek - Harvard Av.	Mixed	2	<50	<50	<50	<50
Marshburn Slough - Irvine Blvd.	Nursery	1	<40	<40	<40	<40
Hines at Weir	Nursery	5	<40	45	41	<40

Chlorpyrifos Data Summary

Table C-11 summarizes the chlorpyrifos results. The detection frequency is lower than for diazinon. This is due in part, to the lower solubility of chlorpyrifos, and its greater affinity for sediment (Table C-1). As discussed in Section I, the lower mobility of chlorpyrifos results in lower concentrations in the drainage channels, despite the fact that over twice as much chlorpyrifos is applied as compared to diazinon (lbs. ai) (Tables C-4 and C-6),

The average values for stormflow and baseflow exceed the chronic numeric targets. Within the drainage channels, 44% of the chlorpyrifos results exceeded the freshwater chronic target (14 ng/L), while 92% of the samples collected in Upper Newport Bay were over the saltwater chronic target (9 ng/L).

Table C-11. Summary of Chlorpyrifos Sampling Results

Source	Count	# of Detects	Det. Freq	Min.	Max.	Mean	Median
Water (ng/L)							
Drainage Channels (All flows)	198	89	45%	ND	770	139	<50
Baseflow	104	36	35%	ND	670	162	<40
Stormflow	94	53	56%	ND	770	123	50
Upper Newport Bay	24	24	100%	2	132	43.3	41.5
Rainfall	1	1	--	--	23	--	--
Sediment (ug/kg)							
Drainage Channels	2	2	100%	17	29	--	--

Freshwater Numeric Targets: acute = 20 ng/L; chronic = 14 ng/L (CDFG 2000a)
Saltwater Numeric Targets: acute = 20 ng/L; chronic = 9 ng/L (CDFG 2000a)

The sediment data for chlorpyrifos is reflective of the higher soil adsorption coefficient relative to diazinon. Although chlorpyrifos analyses were not presented in the OCPFRD data, chlorpyrifos was detected in both sediment samples collected by the CDFG (2000b).

Table C-12 presents the chlorpyrifos data summarized by waterbody group. Detection frequencies were low, particularly in the upper reaches of the watershed. Detection frequencies were higher in Peters Canyon Channel and its tributaries, where a large proportion of the samples were from undiluted nursery discharges. Comparison to the acute and chronic numeric targets is difficult because they are set at levels below the analytical reporting limit used for most of the sampling/monitoring programs. In Table C-12, all detections exceeded the acute and chronic targets. In Upper n

Table C-12. Chlorpyrifos Results by Waterbody Group

Waterbody	Count	Results (ng/L)			Exceedances*	
		Max	Mean	Median	Above acute	Above chronic
Tributaries to SDC Reach 2	24	121	51	<40	33%	33%
Tributaries to SDC Reach 1	21	770	95	<40	10%	10%
Tributaries to P CC	41	670	108	50	54%	54%
Peters Canyon Channel	15	420	83	57	60%	60%
SDC Reach 1	59	580	102	57	59%	59%
Tributaries to UNB	35	231	47	<40	37%	37%
Upper Newport Bay	24	132	43.3	41.5	80%	92%

SDC = San Diego Creek; PCC = Peters Canyon Channel; UNB=Upper Newport Bay
* The reporting limit for chlorpyrifos in freshwater was above the acute and chronic numeric targets, therefore all detected concentrations exceeded the numeric targets.

San Diego Creek Reach 2: There were no samples collected from within Reach 2, however, samples collected from tributary channels discharging into Reach 2 had a low detection frequency (33%) and a maximum concentration of 121 ng/L.

San Diego Creek Reach 1: Samples collected from locations in Reach 1 of San Diego Creek (at Campus, Coronado, and Harvard streets) had a relatively high detection frequency and the highest median concentration, along with Peters Canyon Channel. This may indicate that the greater part of the chlorpyrifos loading is derived from Peters Canyon Channel and its sampled tributaries (Hines, Central

Irvine). However, the maximum chlorpyrifos concentrations occurred in two samples collected from San Joaquin Creek, which discharges directly into Reach 1 of San Diego Creek.

Upper Newport Bay: Chlorpyrifos was detected in all samples collected in Upper Newport Bay, where a lower detection limit was employed. The samples were collected over several days during a storm event in January 1999. The chlorpyrifos concentration that saltwater organisms are exposed to is largely dependent on the degree of mixing between saltwater and freshwater in the upper bay. In the case of the storm sampled in January 1999, a freshwater lens persisted for several days in the upper bay. Chlorpyrifos concentrations were inversely correlated with salinity. Overall, the observed concentrations were lower in Upper Newport Bay than in San Diego Creek.

Chlorpyrifos Sources Categorized by Land Use

Tables C-13a and C-13b present the chlorpyrifos results by sampling location along with the land use pattern in the monitored sub-watershed. The locations in Table C-13a are sorted according to median stormwater runoff concentration, while in Table C-13b, they are sorted according to median baseflow concentration.

Stations sampling runoff derived from mixed land use areas tended to have the highest chlorpyrifos concentrations under both baseflow and stormflow conditions. A major exception was the data from San Joaquin Creek. This creek was sampled during two separate storm events in February, 2000. (Baseflow samples were not collected). The results were the two highest chlorpyrifos concentrations (770 ng/L and 470 ng/L) in the entire dataset. This sample was also associated with very high concentrations of carbaryl that were determined to originate from agricultural fields planted with strawberries that were treated with pesticides immediately prior to a rainfall event.

Chlorpyrifos was not detected in the two stormflow samples collected at the second non-nursery agricultural location (Sand Canyon Ave - NE corner Irvine Blvd). Therefore, it may be prudent to avoid assigning a median concentration to the entire watershed for non-nursery agriculture based on this limited data set.

It is difficult to draw strong conclusions from the data in Tables C-13a and C-13b due to the limited number of samples at most of the locations, and the large number of non-detect results. The chlorpyrifos results also do not correlate well with the diazinon results; the locations with the higher diazinon concentrations do not generally yield the higher chlorpyrifos concentrations. The sampling locations at Westcliff Park and the Central Irvine Channel at Monroe were the only locations among the top seven stormflow results for both chlorpyrifos and diazinon. The baseflow results had a somewhat better correlation, but overall the data suggest differing usage patterns for chlorpyrifos and diazinon.

Sample locations monitoring residential areas tended to have lower chlorpyrifos concentrations. Chlorpyrifos was not detected at three of the residential locations under either baseflow or stormflow conditions. The detection frequency, and maximum concentrations detected at another partly residential location (Santa Ana Delhi Channel) were low. The only residential site with relatively high chlorpyrifos concentrations was Westcliff Park (stormflow), but the baseflow concentrations were relatively low.

Although it appears that some of the nursery/agricultural locations yield higher chlorpyrifos concentrations than the residential areas, it should be noted that the nursery monitoring locations are selected to monitor undiluted nursery discharge, very close to where the chlorpyrifos is used. In contrast, runoff water quality data from individual homes or from distinct residential neighborhoods were not available. Rather data were collected from drainage channels receiving mixed/diluted runoff from many residential neighborhoods. In addition, because of the relative immobility of chlorpyrifos, and its tendency to adsorb to sediment, higher chlorpyrifos concentrations are most likely to be encountered only near areas where it is applied, before it partitions out of the aqueous phase and settles out along with the sediment.

Table C-13a: Land Use and Stormflow Chlorpyrifos Concentrations Newport Bay Watershed: 1996-2000

Station	Land Use	Count	Results (ng/L)			
			Min	Max	Avg	Median
San Joaquin Creek – Univ Dr.	agricultural-open	2	470	770	620	620
San Diego Creek – Harvard Av.	Mixed	2	190	310	250	250
Central Irvine Channel - Monroe	ag(nursery)-residential	2	70	150	110	110
Westcliff Park	Residential	9	<40	231	97	94
Peters Canyon Channel - Barranca	Mixed	10	<40	102	72	69
Marshburn Slough – Irvine Blvd.	Nursery	7	45	121	74	62
San Diego Creek – Campus Dr.	Mixed	25	<40	260	87	57
Hines Channel - Irvine Blvd.	Nursery	9	<40	349	98	<50
Santa Ana Delhi Channel - Mesa Dr.	residential-urban	10	<40	55	48	<40
Drain at Bee Canyon and Portola Pkwy.	Nursery	7	<40	60	43	<40
Sand Canyon Ave - NE corner Irvine Blvd.	Agricultural	2	<50	<50	<50	<50
East Costa Mesa Channel - Highland Dr.	Residential	2	<50	<50	<50	<50
El Modena-Irvine Channel upstream of Peters Canyon Channel	Residential	1	<50	<50	<50	<50
Bonita Creek at San Diego Creek	Residential	7	<40	<40	<40	<40

Table C-13b: Land Use and Baseflow Chlorpyrifos Concentrations Newport Bay Watershed: 1996-2000

Station	Land Use	Count	Results (ng/L)			
			Min	Max	Avg	Median
San Diego Creek – Harvard Av.	mixed	2	50	400	225	225
Central Irvine Channel – Monroe	ag(nursery)-residential	2	<50	281	166	166
Peters Canyon Channel – Walnut	mixed	1	150	150	150	150
Central Irvine Channel – Bryan St	agricultural-residential	5	<40	315	164	117
Hines Channel - Irvine Blvd.	nursery	10	40	670	158	88
San Diego Creek – Campus Dr.	mixed	28	<40	580	111	56
Peters Canyon Channel – Barranca	mixed	4	50	420	144	54
El Modena	nursery	3	<40	57	49	49
Santa Ana Delhi Channel - Mesa Dr.	residential-urban	6	<40	50	37	<40
East Costa Mesa Channel - Highland Dr.	residential	1	<50	<50	<50	<50
El Modena-Irvine Channel upstream of Peters Canyon Channel	residential	1	<50	<50	<50	<50
Westcliff Park	residential	7	<40	129	51	<40
Marshburn Slough - Irvine Blvd.	nursery	1	<40	<40	<40	<40
Hines at Weir	nursery	5	<40	63	45	<40
Drain at Bee Canyon and Portola Pkwy.	nursery	7	<40	<40	<40	<40
San Diego Creek – Coronado St.	mixed	2	<40	<40	<40	<40
Bonita Creek at San Diego Creek	residential	12	<40	<40	<40	<40

Point Sources

There are over fifteen waste discharge requirement (WDR) and NPDES permit holders in the Newport Bay watershed. In addition, three general NPDES permit exist within the San Diego Creek watershed. Some of these permits are in the process of being rescinded.

NPDES

Most of the NPDES permits are minor permits for discharge of extracted groundwater. These are not expected to be sources of diazinon and chlorpyrifos loads to the watershed (groundwater is discussed further below), and the dischargers are not required to monitor for OP pesticides. Two NPDES permits are classified as major permits and are discussed below.

NPDES - Stormwater Runoff:
Stormwater runoff in the Newport Bay watershed is regulated by an NPDES permit for Orange County. As discussed in Section 2, the OCPFRD monitoring program does not include analysis for organophosphate pesticides. However, considerable data have been collected from stormwater runoff channels as part of the 205j, 319h, and CDPR investigations.

NPDES - Sewage Treatment Plants:
Diazinon has been found in effluent from sewage treatment plants (USEPA 1999a). This may be dues to improper disposal of surplus pesticides into sewer drains, or to indoor diazinon usage in urban areas (TDC Environmental 2001). The Newport Bay Watershed residential use survey has indicated a lack of knowledge among homeowners concerning proper disposal procedures (Wilen 2001). There are no sewage treatment plants in the Newport Bay Watershed that discharge effluent to the drainage channels or Newport Bay.

General Permits:
Three general permits have dischargers enrolled within the watershed. Two of the general permits, (groundwater cleanup, and dewatering) are for groundwater discharge. Discharges associated with these permits are not expected to be a source of diazinon or chlorpyrifos (see groundwater discussion below). The third general permit is for boatyards, and includes six enrollees located in Newport Beach. Diazinon/chlorpyrifos usage at boatyards is not expected to differ significantly from general urban uses. The permit prohibits discharge of water to Newport Bay with the exception of stormwater runoff after the first 1/10th inch of precipitation. In short, the boatyards are not regarded as a significant source of OP pesticide runoff.

Santa Ana RWQCB permits:

Nursery Waste Discharge Requirements (WDR):
There are three commercial nurseries in the Newport Bay watershed that are regulated under WDRs. WDRs are being prepared for an additional two nurseries. Together, these nurseries account for less than two percent of the area in the Newport Bay Watershed. As part of the nutrient TMDL for Newport Bay (1999) nurseries greater than five acres and discharging to tributaries that enter Newport Bay were required to institute a regular monitoring program. The monitoring program includes bi-monthly monitoring for toxicity, however, there is no requirement for analysis of OP pesticides. Several of the sampling locations for the 205j, 319h and DPR-RIFA studies were chosen to monitor discharges from nurseries to the drainage channel network. The highest diazinon results occurred in Hines channel and the Drain at Bee Canyon and Portola Parkway sampling station. These results reflect relatively undiluted discharge from agricultural (mostly nursery) areas.

Other WDRs:
Several other facilities (including three landfills) have WDRs but none are required to monitor for OP pesticides, and they are not considered to be significant sources of OP pesticide load

Groundwater

Although there are no currently available groundwater data for diazinon and chlorpyrifos in the Newport Bay watershed, groundwater does not appear to be contributing diazinon and chlorpyrifos loads to the drainage system. Diazinon and chlorpyrifos concentrations are lower downstream of areas where groundwater seeps into the drainage channels. This indicates that the groundwater serves to dilute the concentrations.

In general, diazinon and chlorpyrifos tend to dissipate from the ground surface or in the upper soil layers before percolating to groundwater. Diazinon and chlorpyrifos have not been detected in groundwater sampling conducted by the USGS in the lower Santa Ana River Basin.

Sediment Remobilization

As discussed in the fate and transport section, diazinon has a relatively low potential to adsorb to sediment while chlorpyrifos has a greater adsorption coefficient (Table C-1). Chlorpyrifos could accumulate in sediment and be gradually released into the water through desorption. This would require stability of the adsorbed chlorpyrifos, but adsorbed chlorpyrifos is still subject to chemical hydrolysis and biodegradation.

The available sediment data demonstrate that diazinon is not being bound to sediment. As shown in Table C-8, the detection frequency for diazinon in sediment samples is less than two percent.

Two sediment samples were collected by the CDFG in July/August 2000. Chlorpyrifos was detected in sediment from Hines channel (29 ng/g) and in sediment collected nine miles downstream from the nurseries in San Diego Creek (17 ng/g) (CDFG 2000b). Diazinon was not detected at either location (reporting limit of 10 ng/g dry weight)

As part of the semi-annual sampling program, the OCPFRD collected 96 sediment samples from the Newport Bay watershed and 54 sediment samples from the Bay itself from 1994-1999. Only four diazinon detections were reported. All the detections occurred in 1994, at concentrations of 40 ug/kg to 60 ug/kg. Reporting limits ranged from 35 ug/kg to 400 ug/kg. OCPFRD does not currently monitor sediment for chlorpyrifos.

Atmospheric Deposition

Diazinon is one of the most frequently detected pesticides in air, rain, and fog (USEPA 1999a). In sampling conducted in California in 1988, diazinon was detected in approximately 90% of the sites sampled. Chlorpyrifos has a vapor pressure in the same range as diazinon, and can be expected to volatilize from treated areas. It is not as commonly detected in the atmosphere however.

A rainwater sample collected in the Newport Bay watershed during the 205j studies (December 1997) was reported to have a diazinon concentration of 13 ng/L and a chlorpyrifos concentration of 23 ng/L (Lee and Taylor 2001b). For comparison, eight rainwater samples collected in the Castro Valley Creek watershed, an urban watershed in northern California, had a mean diazinon detected concentration of 58 ng/L with a maximum of concentration of 88 ng/L (Katznelson and Mumley 1997).

Higher diazinon concentrations in rainwater have been detected in agricultural areas (over 5,000 ng/L in 1994-95, and ranging from 418 ng/L to 5,463 ng/L in 14 cities located in the Central Valley) but these are likely related to aerial spray applications to orchards – a type of use that is negligible in the Newport Bay Watershed. Rainfall collected in the winter of 1992-93 in the San Joaquin basin contained up to 1,900 ng/L diazinon. The source of this diazinon is "presumed to be droplets from dormant spray applications (not volatilization from treated crops)" (Novartis 1997).

Assuming the measured rainfall concentration is representative for all storm events, and assuming no degradation during runoff, the annual diazinon load derived from rainfall would be approximately 0.7 lbs. This would be about 2% of the mean annual load at the San Diego Creek – Campus station. For chlorpyrifos, the load would be 1.3 lbs., or about 15% of the mean annual load.

It is uncertain whether this contribution is from volatilization from use within the watershed, or from aerial transport from sources outside the watershed. For estimating loads, the contribution from rainfall is already taken into account by the runoff sampling in the watershed. Direct deposition (rainfall falling directly into Upper Newport Bay) would be negligible since the area of the bay relative to the watershed is less than one percent. The diazinon load would be less than 0.0072 lbs., or less than 0.02% of the annual load to the Bay. For chlorpyrifos the load would be 0.0127 lbs. or about 0.15% of the total annual load.

IV. Approach to calculating current loads

This section presents calculations of estimated diazinon and chlorpyrifos loads to San Diego Creek and Upper Newport Bay. Because the TMDL is concentration based, the load information is presented for information purposes only and is not used as a basis for assigning allocations.

Mean annual loads were calculated using mean water column concentrations from the SDC-Campus Station. Mean annual baseflow and stormflow volumes were calculated using the flow data for the SDC-Campus station presented in Part B (Freshwater flow and seasonal variation). Baseflows are defined in Part B as flow rates less than or equal to 20 cfs at the SDC-Campus station. For the purposes of the diazinon and chlorpyrifos TMDL, stormflows are defined as flows greater than 20 cfs at the SDC-Campus station. Using these definitions, mean annual baseflow and stormflow volumes were calculated using the 19 years of flow data summarized in Part B. Loads were then determined by multiplying the mean concentrations with the mean flows. As the SDC-Campus station represents over 95% of the flow in the watershed, loads were not calculated for the other tributaries.

Diazinon

The estimated mean annual diazinon load at the San Diego Creek- Campus station is about 32 lbs (Table C-14). This amounts to about 0.3% of the estimated 10,800 lbs of diazinon (ai) that was used within the watershed in 1999. This finding is similar to the results of a recent study in the Castro Valley (urban) watershed. That study found that 0.3% of the applied diazinon (ai) was discharged into Castro Valley Creek with 90% of the load delivered by storm runoff (Scanlin and Feng 1997).

Table C-14: Estimated Mean Annual Diazinon Load
San Diego Creek – Campus Station

Flow	Mean Annual Flow (acre-feet)	Mean Conc. (ng/L)	Load (lbs.)	Load (%)
Base flow	6,323	200	3.43	10
Storm flow	26,950	445	32.6	90
Total	33,273	--	36.0	100

Table C-15 presents summary diazinon results categorized by land use, and estimates of the annual load for baseflow and stormflow. Only samples from locations where either urban or non-urban (agriculture, nursery) land use predominated were included in generating the table; about 40% of the samples in the data set were excluded.

Table C-15: Diazinon Concentrations and Loads by Land Use

			Results (ng/L)			Area		Load		Load
Condition	LandUse	Count	Max	Avg	Median	(acres)	(%)	(lbs)	(%)	(lbs/acre)
Baseflow	Urban	27	2,250	236	140	66,507	68%	2.4	88.4%	3.61E-05
	Agriculture	27	10,000	1,002	131	9,286	10%	0.31	11.6%	3.38E-05
	Open	---	---	---	---	21,948	22%	0.0	0.0%	0.00E+00
	Total					97,741	100%	2.7	100%	2.78E-05
Stormflow	Urban	27	1,079	400	370	66,507	68%	24.1	96.3%	3.63E-04
	Agriculture	27	7,990	627	271	9,286	10%	2.47	2.1%	2.66E-04
	Open	---	---	---	---	21,948	22%	0.0	0.0%	0.00E+00
	Total					97,741	100%	26.6	100%	2.72E-04

The total diazinon load estimated from Table C-15 is not directly comparable with the total load calculated using the average data from San Diego Creek (Table C-14) because the data sets are different. The table is simply intended to compare export rates from urban and agricultural areas. On a per-acre basis, diazinon export rates appear to be slightly higher for urban areas than for agricultural areas.

The intensive residential investigation in the Castro Valley Creek watershed (Scanlin and Feng 1997) revealed that a small number of individual residential hotspots (2% to 4% of the homes) produced the bulk of the diazinon loading to the Creek. Controlled experiments to evaluate diazinon runoff from individual homes demonstrated that even when diazinon was used properly, very high levels of diazinon would still be found in the runoff. Highest source areas were patios and driveways, followed by roof drains. These results are probably due to the lower rates of dissipation from these surfaces as compared to lawns or soil, where biodegradation would be much more significant.

Chlorpyrifos

Table C-16 presents an estimate of the annual chlorpyrifos loading to San Diego Creek and Upper Newport Bay. The total annual mass of chlorpyrifos entering Upper Newport Bay is about 8 pounds. This is about 0.03% of the estimated 24,300 lbs. ai of chlorpyrifos applied in the watershed in 1999 (one-fifth of the Orange County total given in Table C-6). This load is based on a conservative estimate of chlorpyrifos concentrations in tributaries to Upper Newport Bay. Actual concentrations in Upper Newport Bay would be reduced due to mixing and dilution.

Table C-16. Estimated Mean Annual Chlorpyrifos Load
San Diego Creek – Campus Station

Flow	Annual Flow (acre ft.)	Mean Conc. (ng/L)	Load (lbs.)	Load (%)
Baseflow	6,323	111	1.91	23
Stormflow	26,950	86.8	6.36	77
Total	33,273	--	8.27	100

Table C-17 presents chlorpyrifos concentrations and loads categorized by land use for the baseflow and stormflow conditions. Compared to diazinon, urban areas contribute a lesser percentage of the stormflow chlorpyrifos load. On a per-acre basis, export rates for urban and agricultural areas are similar. The total chlorpyrifos load estimated from Table C-17 is not directly comparable with the total load calculated using the data from San Diego Creek (Table C-16). The discrepancy between the two methods results from the differing data sets.

Table C-17: Chlorpyrifos Concentrations and Loads by Land Use

		Results				Area		Load		Load
Condition	**Land Use**	**Count**	**Max**	**Det Freq.**	**Median**	**(acres)**	**(%)**	**(lbs)**	**(%)**	**(lbs/acre)**
Baseflow	Urban	27	129	14%	<40	66,507	68%	0.69	87.7%	1.03E-05
	Agriculture	27	670	35%	<40	9,286	10%	0.10	12.3%	1.03E-05
	Open	---	---	---	---	21,948	22%	0.00	0.0%	0.00E+00
	Total					97,741	100%	**0.78**	100%	8.01E-06
Stormflow	Urban	27	231	33%	<40	66,507	68%	2.61	85.1%	3.92E-05
	Agriculture	27	770	56%	50	9,286	10%	0.46	14.9%	4.90E-05
	Open	---	---	---	---	21,948	22%	0.00	0.0%	0.00E+00
	Total					97,741	100%	**3.06**	100%	3.13E-05

V. Summary and conclusions

The following conclusions are based on data collected in Newport Bay watershed prior to implementation of EPA re-registration agreements for chlorpyrifos and diazinon:

Reported and unreported urban uses account for over 90% of total chlorpyrifos and diazinon use in Orange County and in the Newport Bay Watershed.

About 36 pounds of diazinon is discharged annually to San Diego Creek, mostly during storm events. This amounts to about 0.34% of the applied diazinon mass in the watershed. About 8 pounds of chlorpyrifos are annually discharged to Upper Newport Bay, with 77% of the load delivered during storm events. This amounts to about 0.03% of the applied chlorpyrifos mass.

Surface runoff is the source of virtually all the loadings. Contributions from sediment remobilization and groundwater are negligible, however, loading from atmospheric deposition to Upper Newport Bay is potentially significant, though not well-quantified.

On a per acre basis, different land uses contribute diazinon and chlorpyrifos runoff at fairly equal rates within the watershed. Runoff derived from urban land uses accounts for about 88% of the diazinon baseflow load, and 96% of the stormflow load. Agricultural sources (including nurseries) account for the remainder of the load. For chlorpyrifos, runoff derived from urban land uses accounts for about 85% to 88% of the baseflow and stormflow loads, while agriculture (including nurseries) accounts for about 12% to 15% of the load.

Average diazinon concentrations in San Diego Creek exceeded the chronic numeric target, and 95% of the observed concentrations were also above the acute numeric target.

Average chlorpyrifos concentrations in San Diego Creek exceeded the chronic numeric target, and at least 59% of the observed concentrations exceeded the acute numeric target. The average chlorpyrifos concentration observed in Upper Newport Bay during a storm event exceeded the saltwater chronic numeric target, and 80% of the concentrations exceeded the acute numeric target.

The diazinon re-registration agreement by EPA will likely end over 90% of current diazinon use in the Newport Bay watershed. If runoff concentrations show a corresponding decline, diazinon concentrations in San Diego Creek could decrease below the chronic numeric target (50 ng/L).

The chlorpyrifos re-registration agreement by EPA will likely end over 90% of current chlorpyrifos use in the Newport Bay watershed. If runoff concentrations show a corresponding decline, chlorpyrifos concentrations in San Diego Creek and Upper Newport Bay could decline below the respective chronic numeric targets for freshwater and saltwater.

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